STANDARD	
ISO : 898-1 EN : 20898-1 DIN : –	

MECHANICAL PROPERTIES

of steel bolts, screws and studs

info

1 Scope and field of application

The property classes and their mechanical properties apply to bolts, screws and studs, with metric (ISO) thread, with nominal thread diameter d ≤ 39 mm, made of carbon steel or alloy steel and when tested at room temperature.
They do not apply to set screws and similar (see ISO 898-5) or to specific requirements such as weldability, corrosion resistance (see ISO 3506 on page 15-40-1 and seq), ability to withstand temperatures above + 300°C or below - 50°C (see DIN 267 Part 13 on pages 15-5-3 and 4).
The designation system may be used for sizes (e.g. d > 39 mm), provided that all mechanical requirements of the property classes are met.

2 Designation system of property classes

The property class symbols, indicating the most important mechanical properties, consist of two figures, one on either side of a dot. For example, 10.9. The first figure indicates 1/100 of the nominal tensile strength in N/mm² (See R_m in the table).
So property class 10.9 has a tensile strength of 10 x 100 = 1000 N/mm².
The second figure indicates 10 times the ratio between lower yield stress R_{el} (or proof stress $R_{p0,2}$) and nominal tensile strength R_m (yield stress ratio).
So at property class 10.9 the second figure $9 = 10 \times \frac{900}{1000}$
The multiplication of these two figures will give 1/10 of the yield stress in N/mm², so 10 x 9 = 1/10 x 900 N/mm².

3 Mechanical properties of bolts, screws and studs

	mechanical property		3.6	4.6	4.8	5.6	5.8	6.8	8.8 [1] d<16 mm	8.8 [1] d >16 mm[2]	9.8 [3]	10.9	12.9
1	tensile strength R_M [4] N/mm²	nom.	300	400		500		600	800	800	900	1000	1200
2		min.	330	400	420	500	520	600	800	830	900	1040	1220
3	Vickers hardness HV F ≥ 98N	min.	95	120	130	155	160	190	250	255	290	320	385
		max.	250						320	335	360	380	435
4	Brinell hardness HB F = 30 D²	min.	90	114	124	147	152	181	238	242	276	304	366
		max.	238						304	318	342	361	414
5	Rockwell hardness HR	min. HRB	52	67	71	79	82	89	-	-	-	-	-
		min. HRC	-	-	-	-	-	-	22	23	28	32	39
		max. HRB	99,5						-	-	-	-	-
		max. HRC	-						32	34	37	39	44
6	Surface hardness HV 0,3	max.	-						5)				
7	Lower yield stress R_{el} 6) N/mm²	nom.	180	240	320	300	400	480	-	-	-	-	-
		min.	190	240	340	300	420	480	-	-	-	-	-
8	Proof stress Rp 0,2 N/mm²	nom.	-						640	640	720	900	1080
		min.	-						640	660	720	940	1100
	Stress under proofing	Sp_r/R_{el} or Sp/Rp 0,2	0,94	0,94	0,91	0,93	0,90	0,92	0,91	0,91	0,90	0,88	0,88
	load, Sp	N/mm²	180	225	310	280	380	440	580	600	650	830	970
10	Elongation after fracture A in %	min.	25	22	14	20	10	8	12	12	10	9	8
11	Strength under wedge loading		The values for full size bolts and screws (not studs) shall not be smaller than the minimum values for tensile strength shown in 5.2										
12	Impact strength, J	min.	-			25	-		30	30	25	20	15
13	Head soundness		no fracture										
	Minimum height of non-decarburized thread zone, E		-						$^1/_2H_1$			$^2/_3H_1$	$^3/_4H_1$
14	Maximum depth of complete decarburization,G		-						0,015				

1) For class 8.8 in diameter d ≤ 16 mm there is an increased risk of nut stripping in the case of inadvertent over-tightening inducing a load in excess of proofing load. Reference to ISO 898-2 is recommended.
2) For structural bolting the limit is 12 mm.
3) Applies only to nominal thread diameter d ≤ 16 mm.
4) Min. tensile properties apply to products of nominal length l ≥ 2,5 d. Min. hardness applies to products of l < 2,5 d and other products, which cannot be tensile-tested (e.g. due to head configuration).
5) Surface hardness shall not be more than 30 Vickers points above the measured core hardness on the product when readings of both surface and core are carried out at HV 0,3. For class 10.9 max. surface hardness = 390 HV.
6) In cases where the lower yield stress R_{el} cannot be determined, it is permissible to measure the proof stress $R_{p0,2}$.

Guide for properties at elevated temperatures
(No integral part of the standard)

Property class	+20°C	+100°C	+200°C	+250°C	+300°C
	Lower yield stress, R_{el} or proof stress $R_{p0,2}$ N/mm²				
5.6	300	270	230	215	195
8.8	640	590	540	510	480
10.9	940	875	790	745	705
12.9	1100	1020	925	875	825

4 Marking of bolts, screws and studs

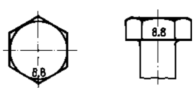


fig. 1

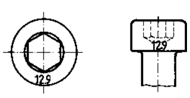
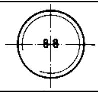


fig. 2

- Marking of all property classes is obligatory for hexagon bolts and screws with nominal diameters d ≥ 5 mm, preferably on top of the head (fig. 1).
- Marking of property classes ≥ 8.8 is obligatory for hexagon socket head cap screws with nominal diameter d ≥ 5 mm, preferably on the top of the head (fig. 2).
- When low carbon martensitic steels are used for class 10.9, the symbol 10.9 shall be underlined: <u>10.9.</u> (See also page 15-10-5).
- Studs shall be marked for property classes ≥ 8.8 and with nominal diameter d ≥ 5 mm. For studs with interference fit, the marking shall be at the nut end (fig. 3). Alternative identification with symbols (fig. 4) is permissable.
- Left-hand thread shall be marked for nominal diameters d ≥ 5 mm with the symbol shown in figure 5 either on the top of the head or the point.
  Alternative marking, as shown in fig. 6 may be used for hexagon bolts and screws.
- The trade (identification) marking of the manufacturer is mandatory on all products which are marked with property classes.
- For other types of bolts and screws the same marking system shall be used. For special components marking will be as agreed between the interested parties.

fig. 3


Property class	8.8	9.8	10.9	12.9
identification symbol	O	+	□	Δ

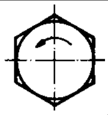
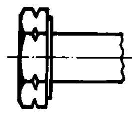
fig. 4


fig. 5


fig. 6


STANDARD	
ISO	: 898-7
EN	: –
DIN	: 267 Part 25

MECHANICAL PROPERTIES

of steel bolts and screws M1 to M10

breaking torques

info

1. Field of application

This standard incorporates a functional evaluation of the mechanical properties as given in ISO 898 Part 1 by torsion testing to determine the minimum breaking torque before failure has been attained.

These data apply to bolts and screws smaller than size M3 in respect of which no breaking load or proof load values are specified in ISO 898 Part 1 and to short M3 to M10 bolts and screws on which no tensile test can be carried out. This standard does not apply to hexagon socket set screws as specified in DIN 913 en DIN 916, nor to case hardened bolts and screws. Also the property classes 3.6, 6.8 and 9.8 have not been taken into consideration.

2. Minimum breaking torques

Thread size	Thread pitch	Property Class						
		4.6	4.8	5.6	5.8	8.8	10.9	12.9
		Minimum breaking torque, in Nm						
M1	0,25	0,020	0,020	0,024	0,024	0,033	0,040	0,045
M1,2	0,25	0,045	0,046	0,054	0,055	0,075	0,092	0,10
M1,4	0,3	0,070	0,073	0,084	0,087	0,12	0,14	0,16
M1,6	0,35	0,098	0,10	0,12	0,12	0,16	0,20	0,22
M2	0,4	0,22	0,23	0,26	0,27	0,37	0,45	0,50
M2,5	0,45	0,49	0,51	0,59	0,60	0,82	1,0	1,1
M3	0,5	0,92	0,96	1,1	1,1	1,5	1,9	2,1
M3,5	0,6	1,4	1,5	1,7	1,8	2,4	3,0	3,3
M4	0,7	2,1	2,2	2,5	2,6	3,6	4,4	4,9
M5	0,8	4,5	4,7	5,5	5,6	7,6	9,3	10
M6	1	7,6	7,9	9,1	9,4	13	16	17
M7	1	14	14	16	17	23	28	31
M8	1,25	19	20	23	24	33	40	44
M8 x 1	1	23	23	27	28	38	46	52
M10	1,5	39	41	47	49	66	81	90
M10 x 1	1	50	52	60	62	84	103	114
M10 x 1,25	1,25	44	46	53	54	74	90	100

The minimum breaking torque values given in the table shall apply to bolts and screws assigned to thread tolerance classes 6g, 6f or 6e.

The following shall apply for the determination of the minimum breaking torque:

M_B min. = τ_B min. W_p min.

$W_p$min. = $\frac{\pi}{16}$ .d_3 min.^{3}

τ_B min. = X. R_m min.

M_B is the breaking torque;
τ_B is the torsional strength;
W_p is the polar section modulus of torsion;
R_m is the tensile strength;
X is the strength ratio τ_B/R_m

Strength ratio X

Property class	4.6	4.8	5.6	5.8	8.8	10.9	12.9
Strength ratio X	1	0,99	0,96	0,95	0,84	0,79	0,75

STANDARD	
DIN	: –
ISO	: –
ANSI	: –

MECHANICAL PROPERTIES

of steel nuts

General explanation

In contrast to the standardisation of the mechanical properties of bolts and screws - in which international agreement has been reached, resulting in one generally accepted ISO-standard 898/1 - this is not yet the case with nuts, causing at present a rather complicated situation during a temporary period of transition.

Relevant studies, experiments and calculations (e.g. Alexander) have shown that due to the higher proof loads of ISO 898/2 (see table 2) and the development of modern tightening techniques based on yield strength, the commonly used nuts with 0,8 D height (e.g. DIN 934) do not provide sufficient assurance that the assembly would resist thread stripping during tightening and that an increase of the nominal 0,8 D nut height is required. (see table 1).
This statement is based on the traditional principle of bolted joints with full loadability, that - when advertently overtorqued - the bolt has to break and no thread stripping may occur.

On the other hand, however, the 0,8 D high nuts are so widely adopted in Europe, that a change-over on a short term could not be realized. This is why, besides the new ISO 898/2 with higher proof loads the existing DIN 267 Part 4 with lower proof loads has to be maintained temporarily for the 0,8 D high nuts. To prevent confusion it has become necessary to add two vertical bars to the code numbers in DIN 267 Part 4 e.g. I8I instead of 8, the latter being the symbol of the higher, so-called “ISO” nuts.

Because ISO 898/2 does not yet give information on nuts without defined proof load values (hardness classes), a new DIN-standard DIN 267 Part 24 had to be issued for the time being.
Thus, at present, there are the following four standards dealing with property classes for nuts:

- DIN 267 Part 4	only for the existing “DIN”-nuts with nominal height ≥ 0,8 D (e.g. DIN 934)	(see page 15-5-4)
- ISO 898/2	only for the higher “ISO”-nuts with nominal heights ≥ 0,8 D en ≥ 0,5 D < 0,8 D	(see page 15-5-5)
- ISO 898/6	for metric fine threads and only for the higher “ISO”-nuts.	(see page 15-5-6)
- DIN 267 Part 24	for nuts defined in hardness classes	(see page 15-5-7)

The two DIN-standards will be withdrawn, as soon as ISO 898/2 is completed and generally accepted.

Table 1. Comparison of ISO and DIN widths across flats and nut heights

Nominal size D	Width across flats s		Nut height m: ISO Style 1 (ISO 4032)			ISO Style 2 (ISO 4033)			DIN 934		
	ISO	DIN	min. mm	max. mm	m/D	min. mm	max. mm	m/D	min. mm	max. mm	m/D
M5	8		4,4	4,7	0,94	4,8	5,1	1,02	3,7	4	0,8
M6	10		4,9	5,2	0,87	5,4	5,7	0,95	4,7	5	0,83
M7	11		6,14	6,5	0,93	6,84	7,2	1,03	5,2	5,5	0,79
M8	13		6,44	6,8	0,85	7,14	7,5	0,94	6,14	6,5	0,81
M10	16	17	8,04	8,4	0,84	8,94	9,3	0,93	7,64	8	0,8
M12	18	19	10,37	10,8	0,90	11,57	12	1,00	9,64	10	0,83
M14	21	22	12,1	12,8	0,91	13,4	14,1	1,01	10,3	11	0,79
M16	24		14,1	14,8	0,92	15,7	16,4	1,02	12,3	13	0,81
M18	27		15,1	15,8	0,88	16,9	17,6	0,98	14,3	15	0,83
M20	30		16,9	18	0,90	19	20,3	1,02	14,9	16	0,8
M22	34	32	18,1	19,4	0,88	20,5	21,8	0,93	16,9	18	0,82
M24	36		20,2	21,5	0,90	22,6	23,9	1,00	17,7	19	0,79
M27	41		22,5	23,8	0,88	25,4	26,7	0,99	20,7	22	0,81
M30	46		24,3	25,6	0,85	27,3	28,6	0,95	22,7	24	0,8
M33	50		27,4	28,7	0,87	30,9	32,5	0,98	24,7	26	0,79
M36	55		29,4	31	0,86	33,1	34,7	0,96	27,4	29	0,81
M39	60		31,8	33,4	0,86	35,9	37,5	0,96	29,4	31	0,79

Table 2. Comparison of ISO and DIN proof loads.

Nominal size mm		property classes nuts: 5		8		10		12	
		proofload in N/mm²							
over	up to	ISO 898/2	DIN 267/4	ISO 898/2	DIN 267/4	ISO 898/2	DIN 267/4	ISO 898/2	DIN 267/4
-	4	520	500	800	800	1040	1000	1150	1200
4	7	580	500	810	800	1040	1000	1150	1200
7	10	590	500	830	800	1040	1000	1160	1200
10	16	610	500	840	800	1050	1000	1190	1200
16	39	630	500	920	800	1060	1000	1200	1200

For further details see explanatory notes and annexes in the appropriate standards.

STANDARD
DIN : 267 Part 4 (W)
ISO : –
ANSI : –

MECHANICAL PROPERTIES

of steel “DIN”-nuts
with proof loads as per DIN 267 Part 4
with coarse and fine thread

1 Field of application

The property classes and their mechanical properties mentioned below apply to nuts with metric ISO thread with coarse and fine pitch and thread tolerances 6 G and 4 H to 7 H, with nominal thread diameters up to and including 39 mm, with width across flats or external diameters not less than 1,45 D and heights not less than 0,8 D (including the normal countersunk on the thread), made of carbon steel or low alloy steel and when tested at room temperature.

Furthermore they only apply to the existing so-called “DIN”-nuts, where in the product standards for the mechanical properties reference is made to DIN 267 Part 4, e.g. the hexagon nuts DIN 555 and DIN 934.
IT IS ADVISED THAT FOR NEW DESIGNS THE HIGHER “ISO”-NUTS E.G. ISO 4032 OR ISO 4034 WITH THE HIGHER PROOF LOADS OF ISO 898/2 SHOULD BE USED. DIN 267 PART 4 SHALL BE REPLACED IN THE FUTURE BY ISO 898/2.

This standard does not apply to nuts which have to meet special requirements, such as for weldability, corrosion resistance (see DIN 267 Part 11), ability to withstand temperatures above + 300°C or below - 50°C (See DIN 267 Part 13) or locking (see DIN 267 Part 15).

Nuts made from free-cutting steel shall not be used above + 250°C.
There is an increased risk of stripping for assemblies with threads having tolerances wider than 6 g/6 H. The use of this standard for nuts above 39 mm is only permitted, when the nuts meet all the requirements.

2 Designation system of property classes

The symbol for property classes consists of a figure that indicates 1/100 of the proof load stress in N/mm^2.
E.g. class 8 has a proof load stress of 8 x 100 = 800 N/mm^2. This proof load stress is equal to the minimum tensile strength of a bolt, which can be loaded up to the minimum yield strength of the bolt when mated with the nut concerned.
Nuts of a higher property class can generally be used in the place of nuts of a lower class.

To make a clear distinction between the “ISO”-nuts with higher proof load stresses, all “DIN”-nuts shall be marked by a vertical bar on either side of the symbol e.g. |**8**|.

3 Mechanical properties of nuts

Mechanical properties			Property class					
			|**4**|*	|**5**|	|**6**|	|**8**|	|**10**|	|**12**|
Proof load stress	Sp	N/mm^2	400	500	600	800	1000	1200
Vickers hardness	HV 5	max.	302	302	302	302	353	353
Brinell hardness	HB 30	max.	290	290	290	290	335	335
Rockwell hardness	HRC	max.	30	30	30	30	36	36
Widening			see DIN 267 Part 21					
* Only above M 16								

4 Marking of nuts

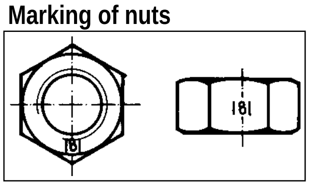


fig. 1

- Hexagon nuts ≥ M 5 shall be marked with the symbol of the property class, a vertical bar on either side of the symbol and the trade (identification) marking of the manufacturer on the bearing surface or side (fig. 1)

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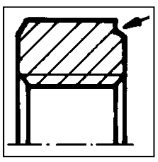

fig. 2

- Hexagon nuts DIN 555 and DIN 934 and castle nuts DIN 935 made from free-cutting steel shall additionally be marked with a groove in one face (fig. 12)

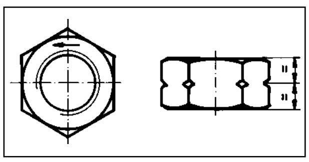

fig. 3

- Left-hand thread shall be marked with a left turning arrow on one bearing surface or a groove halfway up the nut height (fig. 3)

STANDARD	MECHANICAL PROPERTIES
DIN ISO: 898 Part 2 ISO : 898 Part 2 ANSI : –	**of steel "ISO"-nuts** with proof loads as per ISO 898/2 and metric (ISO) thread with coarse pitch

info

1 Scope and field of application

The property classes and their mechanical properties mentioned below apply to nuts with metric ISO thread with coarse pitch and thread tolerance 6 H, with nominal thread diameters up to and including 39 mm, with widths across flats as per ISO 272 and heights ≥ 0,5 D, made of carbon steel or low alloy steel and when tested at room temperature.

Furthermore they only apply to the higher, so-called "ISO"-nuts e.g. ISO 4032 or ISO 4034. This standard does not apply to nuts which have to meet special requirements, such as for weldability, corrosion resistance (see DIN 267 Part 11)), ability to withstand temperatures above + 300°C or below - 50°C (see DIN 267 Part 13) or locking ability (see DIN 267 Part 15).

Nuts made from free-cutting steel shall not be used above + 250°C .

There is an increased risk of stripping for assemblies with threads having tolerances wider than 6 g/6 H

2 Designation system of property classes

2.1 Nuts with nominal heights ≥ 0,8 D (full loading capacity)

Property class of nut	mating bolts: property class	mating bolts: diameter range
4	3.6 4.6 4.8	> M 16
5	3.6 4.6 4.8	≤ M 16
	5.6 5.8	all
6	6.8	all
8	8.8	all
9	8.8	> M 16 ≤M 39
	9.8	≤M 16
10	10.9	all
12	12.9	≤M 39

The designation of the property classes of these nuts consists of a figure to indicate the maximum appropriate property class of bolts with which they may be mated. A bolt or screw assembled with a nut of the appropriate property class in accordance with the table opposite, is intended to provide an assembly capable of being tightened to the bolt load without thread stripping occuring.

Nuts of a higher property class can generally be used instead of nuts of a lower class.

2.2 Nuts with nominal heights ≥ 0,5 D < 0,8 D (reduced loading capacity)

Property class of nut	Nominal proof load stress N/mm²	Actual proof load stress N/mm²
04	400	380
05	500	500

The designation of the property classes of these nuts consists of a combination of two numbers. The first number is 0, which indicates that the loadability is reduced compared with those described in 2.1.

The second number corresponds with 1/100 of the nominal proof load stress in N/mm².

E.g. class 04 has a nominal proof load stress of 4 x 100 = 400 N/mm².

3 Mechanical properties of nuts with metric (ISO) thread with coarse pitch.

Nominal size (thread diameter) mm		Property class 04					05					4					5					6				
		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC	
over	to	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.
-	4																520					600				
4	7											–	–	–	–	–	580	130		–		670	150		–	
7	10	380	188	302	–	30	500	272	353	27,8	36						590		302		30	680		302		30
10	16																610					700				
16	39											510	117	302	–	30	630	146		–		720	170		–	
39	100	–					–					–					–	128	–			–	142		–	

Nominal size (thread diameter) mm		Property class 8					9					10					12						
		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV			Rockwell hardness HRC		
over	to	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/mm²	min.		max.	min.		max.
-	4	800	170		–		900	170		–		1040					1150						
4	7	810		302		30	915					1040					1150						
7	10	830	188		–		940	188	302		30	1040	272	353	28	38	1160	295[1)]	272[2)]	353	31[1)]	28[2)]	38
10	16	840					950					1050					1190						
16	39	920	233	353	–	38	920					1060					1200	–			–		
39	100	–	207		–		–	–	–	–	–	–					–	–	–	–	–	–	–

1) for nuts ISO 4032 (type 1)
2) for nuts ISO 4033 (type 2)

– Minimum hardness is mandatory only for heat-treated nuts and nuts too large to be proof-load tested. For all other nuts minimum hardness is provided for guidance only.
– Hardness values for nominal sizes over 39 up to and including 100 mm are to be used for guidance only.

4 Marking of nuts

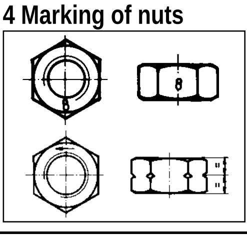

fig. 1 – Hexagon nuts ≥ M 5 and property classes ≥ 8, and classes 05 shall be marked on the side of bearing surface or side with the symbol of the property class and the trade (identification) marking of the manufacturer fig. 1. The alternative marking based on the clock-face system did not find general acceptance.

fig.2 – Left-hand thread ≥ M 6 shall be marked with a left turning arrow on one bearing surface or a groove halfway up the nut height (fig. 2).

STANDARD	MECHANICAL PROPERTIES
DIN ISO: 898 Part 6 ISO : 898 Part 6 ANSI : –	**of steel “ISO”-nuts** with proof loads as per ISO 898/2 and metric (ISO) thread with fine pitch

1 Field of application

The property classes and their mechanical properties mentioned below apply to nuts with metric (ISO) thread with fine pitch and thread tolerance 6 H, with nominal thread diameters of up to and including 39 mm, with widths across flats as per ISO 272 and heights ≥ 0,5 D, made of carbon steel or low alloy steel and when tested at room temperature. Furthermore they only apply to the higher, so-called “ISO”-nuts DIN 971 Part 1 and 2 with metric fine pitch. This standard does not apply to nuts which have to meet special requirements, such as for weldability, corrosion resistance (see DIN 267 Part 11), ability to withstand temperatures above + 300°C or below - 50°C (see DIN 267 Part 13) or locking ability (see DIN 267 Part 15). Nuts made of free-cutting steel shall not be used above + 250°C. There is an increased risk of stripping for assemblies with threads having tolerances wider than 6 g/6 H.

2 Designation system of property classes

2.1 Nuts with nominal heights ≥ 0,8 D (full loading capacity)

Property class of nut	Mating bolts		Nuts	
			Style 1	Style 2
	Property class	Size	Size	
		mm	mm	
6	≤ 6.8	d ≥39	d ≤ 39	–
8	8.8	d ≤ 39	d ≤ 39	d ≤ 16
10	10.9	d ≤ 39	d ≤ 16	d ≤ 39
12	12.9	d ≤ 16	–	d ≤ 16

The designation of the property classes of these nuts consists of a figure to indicate the maximum appropriate property class of bolts with which they may be mated. A bolt or screw assembled with a nut of the appropriate property class in accordance with the table opposite, is intended to provide an assembly capable of being tightened to the bolt proof load without thread stripping occuring.
Nuts of a higher property class can generally be used instead of nuts of a lower class.

2.2 Nuts with nominal heights ≥ 0,5 D ≤ 0,8 D (reduced loading capacity)

Property class of nut	Nominal proof load stress N/mm^2	Actual proof load stress N/mm^2
04	400	380
05	500	500

The designation of the property classes of these nuts consists of a combination of two numbers. The first number is 0, which indicates that the loadability is reduced compared with those described in 2.1. The second number corresponds with 1⁄100 of the nominal proof load stress in N/mm^2. E.g. class 04 has a nominal proof load stress of 4 x100 = 400 N/mm^2.

3 Mechanical properties of nuts with metric (ISO) thread with fine pitch

Nominal thread diameter d	Property class 04					05				
	Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut	
mm	N/mm^2	min.	max.	state	style	N/mm^2	min.	max.	state	style
8 ≤ d ≤39	380	188	302	not quenched or tempered	thin	500	272	353	quenched and tempered	thin

STANDARD	MECHANICAL PROPERTIES
DIN ISO: 898 Part 6 ISO : 898 Part 6 ANSI : –	**of steel "ISO"-nuts** with proof loads as per ISO 898/2 and metric (ISO) thread with fine pitch

Nominal thread diameter d	Property class 6					Property class 8									
	Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut	
mm	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style
8 ≤ d ≤ 10	770	188	302	not quenched nor tem-pered1)	1	955	250	353	quenched and tempered	1	890	195	302	not quenched nor tempered	2
10 < d ≤ 16	780														
16 < d ≤ 33	870	233				1030	295				–	–	–		–
33 < d ≤ 39	930					1090									

1) For thread diameters above 16 mm, nuts may be quenched and tempered at the discretion of the manufacturer.

Nominal thread diameter d	Property class 10										Property class 12				
	Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut	
mm	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style
8 ≤ d ≤ 10	1100	295	353	quenched and tempered	1	1055	250	353	quenched and tempered	2	1200	295	353	quenched and tempered	2
10 < d ≤ 16	1110														
16 < d ≤ 33		–	–	–	–	1080	260				–	–	–	–	–
33 < d ≤ 39	–														

NOTE - Minimum hardness is mandatory for heat-treated nuts too large to be proof-load tested.
For all other nuts minimum hardness is not mandatory but is provided for guidance only

4 Marking of nuts

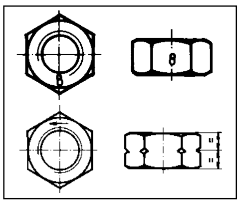

fig. 1 – Hexagon nuts ≥ M5 and property classes ≥ 8 and class 05 shall be marked on the side of bearing surface or side with the symbol of the property class and the trade (identification) marking of the manufacturer (fig. 1). The alternative marking based on the clock-face system did not find general acceptance.

fig. 2 – Left-hand thread ≥ M 6 shall be marked with a left turning arrow on one bearing surface or a groove halfway up the nut height (fig. 2).

STANDARD	MECHANICAL PROPERTIES
DIN : 267 Part 24 ISO : – ANSI : –	**of steel nuts** specified in hardness classes

1 Field of application

This standard specifies the mechanical properties of nuts which, due to shape or dimensions cannnot be tested by proof loads and cannot be defined on the base of proof load stresses.
They have been classified according to minimum hardness values, from which, however, no conclusions can be drawn with regard to the loadability and the stripping strength of the nuts. The performance properties depend on their style.

This standard does not apply to nuts which have to meet special requirements, such as for weldability, corrosion resistance (see DIN 267 Part 11), ability to withstand temperatures above + 300°C or below - 50°C (see DIN 267 Part 13) or locking ability (see DIN 267 Part 15) nor to nuts which have to withstand specified proof loads in accordance with ISO 898/2, DIN 267 Part 4 and ISO 898/6.
Nuts made from free-cutting steel shall not be used above + 250°C.

2 Designation system of property classes

Property class symbol	11 H	14 H	17 H	22 H
Vickers hardness HV 5 min.	110	140	170	220

The designation of the property classes of these nuts consists of a combination of a number and a letter, see table opposite.
The number indicates 1/10 of the minimum Vickers hardness e.g. 14 x 10 = 140 HV.
The letter H stands for the word "hardness".

3 Mechanical properties

Mechanical property		Property class			
		11 H	14H	17 H	22 H
Vickers hardness HV 5	min.	110	140	170	220
	max.	185	215	245	300
Brinell hardness HB 30	min.	105	133	162	209
	max.	176	204	233	285

4 Marking of nuts

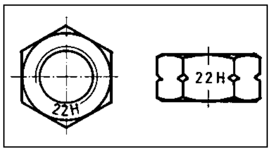

fig 1

– Only property class 22 H nuts shall be marked with the symbol identifying the property class. (fig. 1).

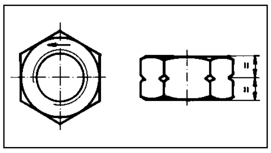

fig. 2

– It is recommended that nuts with left-hand thread be marked with a left turning arrow on one bearing surface or a groove halfway up to the nut height. (fig. 2)

STANDARD	MATERIAL PROPERTIES	info
ISO : – EN : – DIN : –	**of steel bolts, screws and nuts** Steels	

OVERVIEW AND DEFINITIONS OF STEELS FOR FASTENERS

1. The word **steel** is understood to mean a deformable iron (Fe)-carbon (C) alloy with a maximum carbon content of 1,5%. So it is not correct to speak, for example, about iron bolts or rivets. The word “iron” should only be used to indicate the chemical element Fe, 100% pure iron and in the combination of the word malleable iron as distinct from malleable steel.

2. **Unalloyed, low carbon steel** as per DIN 17111 with a C% ≤ 0,22% is used for the lower property classes of bolts, screws and nuts. This steel group is indicated with the letters St followed by a number corresponding with 1/10 of the minimum tensile strength in N/mm^2. For example, St38 has a tensile strength of 10 x 38 = min. 380 N/mm^2.
Depending on the steel processing method, (desoxydation method) a distinction is made between:
– **rimmed steel**, indicated with U before St. In this process gases continue to evolve (boiling) as the steel solidifies.
– **killed steel**, indicated with R before St, that gradually changes from a liquid to a solid when silicon or aluminium is added, resulting in a better quality of structure.
Sometimes an extra quality number 1 or 2 is added. Quality number 2 requires maximum phosporus (P) and sulphur (S) content limits whereas quality number 1 does not.
Example: U St 36-2 is a rimmed, low carbon steel with a minimum tensile strength of 360 N/mm^2 and with a special low P- and S content.
DIN 17111 also includes the so-called **"resulphurized steel"** with an extra, controlled addition of sulphur in the interior section of the material increasing the thread tapping characteristics in the nuts e.g. U 10 S 10. This is a rimmed, low carbon steel of which the first 10 = $\frac{10}{100}$ = 0,1%C and the second 10 = $\frac{10}{100}$ = 0,1% S.

3. **Carbon steel** as per DIN 1654 **cold heading steels**, DIN 17200 **steels for quenching and tempering** and DIN 17210 **case hardening steels**.
The carbon steels can be divided into 3 types:
– **quality steel**, indicated with the letter C followed by the C% mulitiplied by 100. E.g. C 35 is a quality steel with 0,35% C and a P and S% of max 0,045.
– **high quality steel**, indicated with the letters Ck with a lower P and S content. E.g. Ck 35 is a high quality steel with 0,35% C and a P and S% of max 0,035.
– **cold heading steel**, indicated with the letters Cq having special cold forming characteristics. E.g. Cq 35 is a cold heading steel with 0,35% C and a P and S% of max. 0,035.

4. **Alloy steel** as per DIN1654 **cold heading steels**, DIN 17200 **steels for quenching and tempering** and DIN 17210 **case hardening steels**.
In this steel group the percentage of elements - which normally only occur as traces or impurities - has been increased and/or other elements have been added to achieve or improve special characteristics, such as higher mechanical properties, better resistance against corrosion, low or high temperatures, etc.
The designation starts with a number indicating 100 x the C-content, followed by the symbols of the relevant alloying elements in sequence of their quantity, starting with the largest, and finally another number(or series of numbers) indicating a certain ratio of the percentage of the alloying element(s).
– 4 for the elements Cr-Co-Mn-Ni-Si-W
– 10 for the elements Al-Cu-Mo-Ti-V
– 100 for the elements C-P-S-N
– 1000 for the element B (boron)
E.g. 36 Cr Ni Mo 4 is a steel alloyed with Cr, Ni and Mo with $\frac{36}{100}$ = 0,36% C and $\frac{4}{4}$ = 1% Cr.
28 B2 is a borium alloyed steel with $\frac{28}{100}$ = 0,28% C and $\frac{2}{1000}$ = 0,002% B.

The most common elements used with fasteners have the following influence:
– **Carbon (C)** is the most important element and influences the mechanical properties considerably. For fasteners the percentage varies up to 0,5% maximum. With increasing C content the strength increases, but the cold formability is reduced. From about 0,3% C the steel can be heat treated.
– **Nickel (Ni)** improves the through-hardening, toughness at low temperatures and the non-magnetic properties. The combination of at least 8% Ni with about 18% Cr results in the important austenitic stainless steel quality A2.
– **Chromium (Cr)** also increases hardenability and strength. A minimum content of about 12,5% is necessary for a steel to be qualified as stainless.
– **Molybdenum (Mo)** increases hardenability and reduces temper brittleness. High temperature strength is improved. When 2 - 3% Mo is added to an alloy with about 18% Cr and about 12% Ni corrosion resistance increases considerably. This quality of austenitic stainless steel is used frequently for fasteners and is designated with A4.
– **Manganese (Mn)** usually occurs like the elements silicon (Si), phosphorus (P) and sulphur (S) only as impurities. By adding Mn, strength, hardenability and wear resistance are increased. However the steel becomes more sensitive to overheating and temper brittleness.
– **Titanium (Ti)** is used as carbide former for stabilisation against intercrystalline corrosion in e.g. stainless steel. The elements Niobium (Nb) and Tantalium (Ta) cause the same effect..
– **Boron (B)** is a relatively new alloying element in fasteners steel. Very small amounts of 0,002-0,003% already improves the through hardening considerably. Because of this, C% can be kept lower, improving the cold workability. The application of boron treated steels has become a very popular alternative in manufacturing cold formed, heat-treated fasteners.

STANDARD
ISO : –
EN : –
DIN : –

MATERIAL PROPERTIES

Of steel bolts, screws and nuts

steels

5. Case hardening steel as per DIN 17210 and DIN 1654 Part 3.
Case hardening steel has a relatively low carbon content and is used to get a very hard, wear resistant surface by adding carbon during the heat treatment. This type of steel is used for tapping screws, thread cutting and self-drilling screws, chipboard screws, etc..

6. Free cutting steel as per DIN 1651.
This special type of steel is characterized by a good metal removal and short chip breaking. This is achieved by increasing the sulphur content to 0,34% max., sometimes with an extra addition of lead. A very popular type for fasteners is 9S20K with C% ≤ 0,13 and 0,18 - 0,25 S, which is machined in the cold-drawn condition.
The manufacturing method of machining on automatic lathes is no longer used very much for commercial fasteners but it is still applied for small quantities or for a product configuration, which is difficult to cold form.
Free cutting steel has restricted properties.

7. High and low temperature steel as per DIN 267 Part 13, DIN 17240, AD-Merkblätter W7 and W10, SEW680.
For technical data of this special group see section 5 of the catalogue (double end studs).

8. Stainless steel as per DIN 267 Part 11, DIN 1654 Part 5, DIN 17440, and ISO 3506.
For technical data see the chapter “stainless steel” in this section.